Atty. Docket No. OPP031051US
Serial No: 10/722,295

Amendments to the Figures

Please add FIG. 2E as required in the Office Action of November 21, 2005 (see page 2 therein). The new drawing, which is substantially the same as FIG. 2C but with the ends of the anti-reflective coating rounded, is supported by FIG. 2C as originally filed, paragraph [0015] (p. 4, l. 18-p. 5, l. 3) of the specification as originally filed, and claim 6 as originally filed. Thus, the new drawing does not introduce new matter or new issues.

A New Sheet (as required by 37 C.F.R. 1.121(d)) is attached to this Amendment.

Atty. Docket No. OPP031051US
Serial No: 10/722,295

Remarks

Applicant and his representatives wish to thank Examiner Chen for the thorough examination of the present application and the detailed explanations in the Office Action dated November 21, 2005.

The present invention relates to a method of forming a trench in a semiconductor device, including the steps of (a) forming a polish stop layer on a semiconductor substrate, (b) forming an anti-reflection coating on the polish stop layer, (c) selectively etching the anti-reflection coating to form an anti-reflection coating pattern, (d) etching the polish stop layer and etching the semiconductor substrate to a predetermined depth to form a trench such that ends of the polish stop layer adjacent to the trench are rounded, and (e) forming an insulation layer that fills the trench.

The Objection to the Drawings

The objection to the drawings has been obviated by adding a new drawing showing an antireflective coating with rounded ends, as required in the Office Action.

The Objection to the Amendment under 35 U.S.C. § 132(a) and the Rejection of Claims 2-4, 8-10 and 15-17 under 35 U.S.C. § 112, first paragraph

The objection to the Amendment filed September 16, 2005 under 35 U.S.C. § 132(a) and the rejection of claims 2-4, 8-10 and 15-17 under 35 U.S.C. § 112, first paragraph, as failing to comply with the written description requirement is respectfully traversed.

The Amendment filed September 16, 2005 does not introduce new matter. Rather, the Amendment filed September 16, 2005 is supported by the original disclosure.

The Amendment filed September 16, 2005 added the phrase "or more" to claims 2, 4, 8, 10, 15 and 17, and deleted the phrase "one of" from claims 3, 9 and 16. However, one skilled in

the art of semiconductor processing and/or manufacturing understands that these claim amendments are supported by the specification as originally filed.

For example, the present specification discloses dry etching the silicon nitride (polish stop) film 13, the pad oxidation layer 12 and the semiconductor substrate 11 form a trench 100 (p. 7, ll. 14-17), and forming a sidewall polymer in the initial stages of etching the silicon nitride layer 13 (and removing the same) such that the ends of the ARC 14 are etched. One skilled in the art understands that forming a sidewall polymer occurs when dry etching SiO_2 (e.g., a material suitable for pad oxidation layer 12) and Si (the best-known and most widely used semiconductor substrate) with a fluorocarbon plasma (see, e.g., Wolf, "Silicon Processing for the VLSI Era," vol. 1, pp. 678-683, particularly p. 678, first paragraph, p. 680, Fig. 14-19(b) and paragraph #2, and p. 683, Fig. 14-23 and the first full paragraph; attached hereto). Notably, Wolf teaches the well-known formation of sidewall polymer in a process that etches a trench into silicon under a layer of SiO_2 (a well-known structure resulting from the oxidation of silicon) using a mixture of CHF_3 and CF_4 (both of which are recited in claims 2-4, 8-10 and 15-17), or a mixture of a fluorocarbon and O_2 (see Wolf, p. 683, the first paragraph, ll. 11-16, and Fig. 14-23). Therefore, one skilled in the art(s) of semiconductor devices and semiconductor manufacturing would readily understand that the present specification supports dry etching a silicon nitride (polish stop) layer and a semiconductor substrate using a mixture of the etchants recited in claims 2-4, 8-10 and 15-17.

Applicant's undersigned representative understands that O_2 itself does not dry etch silicon nitride, SiO_2 or Si (see also, e.g., Wolf, p. 672, Table 14-2, submitted herewith). As a result, one skilled in the art would understand that, to the extent O_2 is used in the etching step recited in claims 2-4, 8-10 and 15-17, the silicon nitride (polish stop) film 13, the pad oxidation layer 12 and the semiconductor substrate 11 must be etched with a mixture of O_2 and another etchant (e.g., CF_4; also see Wolf, p. 673, first paragraph of section 14.4 [submitted herewith], and Table 14-2 on p. 672). As a result, one skilled in the art(s) of semiconductor devices and semiconductor manufacturing would further understand that the present specification supports

dry etching a silicon nitride (polish stop) layer and a semiconductor substrate using a mixture of the etchants recited in claims 2-4, 8-10 and 15-17.

In addition, one skilled in the art understands that *molecular* gases are used in dry etching (see, e.g., Wolf, pp. 668-9, particularly p. 669, l. 7, attached hereto; emphasis in original). One of the gases recited in claims 2-4, 8-10 and 15-17, Ar (argon), is not a molecular gas. Accordingly, one skilled in the art understands that Ar is not used alone in dry etching (see also, e.g., Wolf, p. 679, the second full paragraph, which teaches the well-known use of Ar ions to assist dry etching processes). One skilled in the art therefore understands that dry etching uses a molecular gas such as CHF_3, CF_4, O_2, or HeO_2, and as a result, the disclosure of Ar as a gas for use in dry etching must refer to its use in combination with one (and possibly more, as discussed above) of the molecular gases recited in claims 2-4, 8-10 and 15-17.

Even further, the present specification discloses that the ARC 14 may be a conventional ARC made of an organic material (p. 7, l. 7-8) and that dry etching to form the trench 100 can be controlled such that a small amount of exposed ends of the ARC layer 14 is removed (p. 7, l. 20-p. 8, l. 1). As is known in the art, dry etching an organic solid (such as the embodiment of the ARC 14 disclosed by the present specification and discussed in this paragraph) can be done with O_2 alone or in combination with CF_4 (see Wolf, p. 672, Table 14-2). As a result, one skilled in the art(s) of semiconductor devices and semiconductor manufacturing would understand that the present specification supports dry etching an ARC using one or more of the etchants recited in claims 2-4, 8-10 and 15-17.

Without doubt, the present specification discloses dry etching with a single gas (see paragraphs [0014] and [0031], pp. 4 and 7-8, respectively). Consequently, those skilled in the art would readily understand that the above-identified application discloses and conveys dry etching the silicon nitride (polish stop) film 13, the pad oxidation layer 12 and the semiconductor substrate 11 using one or more of the gases recited in claims 2-4, 8-10 and 15-17.

To the extent that the disclosures of certain gases in paragraphs [0014] and [0031] of the present specification are considered erroneous, the Amendment filed September 16, 2005 corrects readily apparent errors in the disclosure. Correction of an error is not new matter if one

skilled in the art would appreciate not only the existence of an error, but what the error is. *Koito Mfg. Co. v. Turn-Key-Tech, LLC*, 381 F.3d 1142; 72 U.S.P.Q.2D 1190 (Fed. Cir. 2004), citing *In re Oda*, 58 C.C.P.A. 1353, 443 F.2d 1200, 1206 (C.C.P.A. 1971). As discussed above, one skilled in the art would readily ascertain that any disclosure limiting dry etching the silicon nitride (polish stop) film 13, the pad oxidation layer 12 and the semiconductor substrate 11 to a single gas is erroneous in certain cases (e.g., O_2 and Ar). Thus, to the extent paragraphs [0014] and [0031] of the disclosure are considered to contain one or more errors, correction of such errors is not new matter.

Furthermore, as discussed above, the specification as originally filed supports an amendment reciting dry etching with a mixture of the more than one of the gases. Because the amended subject matter is inherently contained in the originally-filed application, it does not constitute new matter. *Koito Mfg. Co. v. Turn-Key-Tech*, citing *Schering Corp. v. Amgen Inc.*, 222 F.3d 1347, 1352 (Fed. Cir. 2000). Thus, no new matter was introduced by the Amendment filed September 16, 2005.

Therefore, this ground of rejection should be withdrawn.

The Rejection of Claims 1-4, 6, 8-10, 12-17 and 19-20 under 35 U.S.C. § 102(e)

The rejection under 35 U.S.C. § 102(e) of Claims 1-4, 6, 8-10, 12-17 and 19-20 as being unpatentable over Moore et al. (US 6,884,725) are respectfully traversed.

Moore et al. discloses a method of forming a trench in a semiconductor device, where the method includes forming a polish stop layer on a semiconductor substrate, etching the polish stop layer and etching the semiconductor substrate to a predetermined depth to form a trench, and forming an insulation layer that fills the trench. However, Moore et al. fails to disclose or suggest the steps of forming an anti-reflection coating on the polish stop layer or selectively etching the anti-reflection coating to form an anti-reflection coating pattern, as recited in Claim 1 above.

The Office Action appears to presume that the silicon nitride polish stop layer of Moore et al. also serves as an antireflective coating (see, e.g., p. 4, ll. 1-9 of the paragraph below paragraph 2). Such a presumption not only violates the "All-Elements" rule for determining whether a reference anticipates claims, but it is also inconsistent with the knowledge of antireflective coatings in the art.

As is known in the art, antireflective coatings function to reduce or lower the reflectivity at a resist interface (i.e., the interface between a photoresist and an underlying material; see, e.g., Wolf, p. 524, section 12.4.2.6; submitted herewith). When the antireflective coating is between the photoresist and the material being etched (as the silicon nitride layer of Moore is being interpreted in the Office Action), it is a material applied between the substrate (in this case, the silicon nitride layer of Moore) and the resist to reduce S_p by decreasing the value of ρ_{23} (see Wolf, p. 524, section 12.4.2.7, first paragraph). The parameter S_p is the clearing-dose swing ratio, or the ratio of the peak-to-valley change in the clearing dose intensity to the average clearing dose intensity, and is equal to $4*(\rho_{12}\rho_{23})^{1/2}\exp(-\alpha D)$ (see Wolf, p. 522, second full paragraph and equation 12.7). The parameters ρ_{12} and ρ_{23} are the intensity reflection coefficients of the resist and the air-resist interface and of the substrate at the resist-substrate interface (in the case of Moore, the resist-silicon nitride layer interface). It follows that if the substrate being etched and the antireflective coating are the same material, ρ_{23} (the intensity reflection coefficient at the resist-substrate interface) has the same value. Thus, ρ_{23} cannot be decreased by forming an antireflective coating of the same material between the material being etched and the photoresist. Thus, by definition, an antireflective coating must provide an interface with the resist that has an intensity reflection coefficient that is less than that of the interface between the material being etched (the substrate) and the resist.

Consequently, the interpretation of the disclosure of Moore set forth in the Office Action is not consistent with the understanding in the art of antireflective coatings. As a result, Moore cannot be said to disclose forming an antireflective coating on a polish stop layer or etching the antireflective coating to form an antireflective coating pattern, as recited in the present claim 1.

Furthermore, the interpretation of Moore is not consistent with the "All Elements Rule" of patent claim interpretation. According to the All Elements Rule, to establish infringement of a patent, every limitation set forth in a claim must be found in an accused product or process exactly or by a substantial equivalent. *Johnston v. IVAC Corp.*, 885 F.2d 1574, 12 U.S.P.Q.2D (BNA) 1382 (Fed. Cir. 1989), citing 4 D. Chisum, Patents, § 18.03[4] (1986); *Corning Glass Works v. Sumitomo Elec. U.S.A., Inc.*, 868 F.2d 1251, 1259, 9 U.S.P.Q.2D (BNA) 1962, 1968 (Fed. Cir. 1989); *Perkin-Elmer Corp. v. Westinghouse Elec. Corp.*, 822 F.2d 1528, 1533 n. 9, 3 U.S.P.Q.2D (BNA) 1321, 1325 n. 9 (Fed. Cir. 1987). Similarly, to anticipation a claim of a patent application, a single prior art reference must contain every limitation set forth in the claim, explicitly or inherently. See, e.g., *EMI Group North America, Inc., v. Cypress Semiconductor Corp.*, 268 F.3d 1342; 60 U.S.P.Q.2D (BNA) 1423 (Fed. Cir. 2001); *General Electric Co., v. Nintendo Co, Ltd.*, 179 F.3d 1350, 1356; 50 U.S.P.Q.2D (BNA) 1910, 1915 (Fed. Cir. 1999); and many others.

To illustrate, a claim to a stool having a substantially horizontal member supported by four legs is not anticipated by a prior art stool having three legs. The prior art stool does not disclose one of the claim elements (or, more accurately, one of the claim limitations), a fourth leg. It would not be reasonable to argue that the prior art stool having three legs anticipates the claimed stool having four legs because one could, in theory, draw an imaginary line down one of the legs and assert that one leg can be two legs because the legs may have a common function and the claim does not distinguish between the materials in each leg. However, that is effectively the position taken by the USPTO in this case, that a single, unitary structure in the cited reference (i.e., the silicon nitride layer of Moore) anticipates two discrete elements of the present claim 1 because silicon nitride is disclosed as a suitable polish stop layer and is known to provide an antireflective function under certain circumstances (as described by Wolf).

Absent legal precedent for the position that one unitary, undivided structure in a cited reference can be interpreted as two discrete elements of a claim, particularly where claimed subject matter would be understood by those skilled in the art as two discrete elements, the silicon nitride layer of Moore cannot be interpreted as **both** the polish stop layer **and** the

antireflective coating of the present claim 1. Consequently, this ground of rejection is unsustainable, and should be withdrawn.

All of the remaining claims depend, directly or indirectly, on Claim 1. Therefore the rejections under 35 U.S.C. § 102(e) of Claims 1-4, 6, 8-10, 12-17, and 19-20 should be withdrawn.

The Rejections of Claims 5, 11 and 18 under 35 U.S.C. § 103(a)

The rejections under 35 U.S.C. § 103(a) of Claims 5, 11 and 18 as being unpatentable over Moore et al. (US 6,884,725) have been addressed by amendment.

As discussed herein, Moore et al. fails to disclose or suggest the steps of forming an anti-reflection coating on the polish stop layer or selectively etching the anti-reflection coating to form an anti-reflection coating pattern, as recited in Claim 1. Claims 5, 11 and 18 depend indirectly on Claim 1. Therefore the rejections under 35 U.S.C. § 103(a) of Claims 5, 11 and 18 should be withdrawn.

Conclusions

In view of the above amendments and remarks, all bases for objection and rejection are overcome, and the application is in condition for allowance. Early notice to that effect is earnestly requested.

Atty. Docket No. OPP031051US
Serial No: 10/722,295

If it is deemed helpful or beneficial to the efficient prosecution of the present application, the Examiner is invited to contact Applicant's undersigned representative by telephone.

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